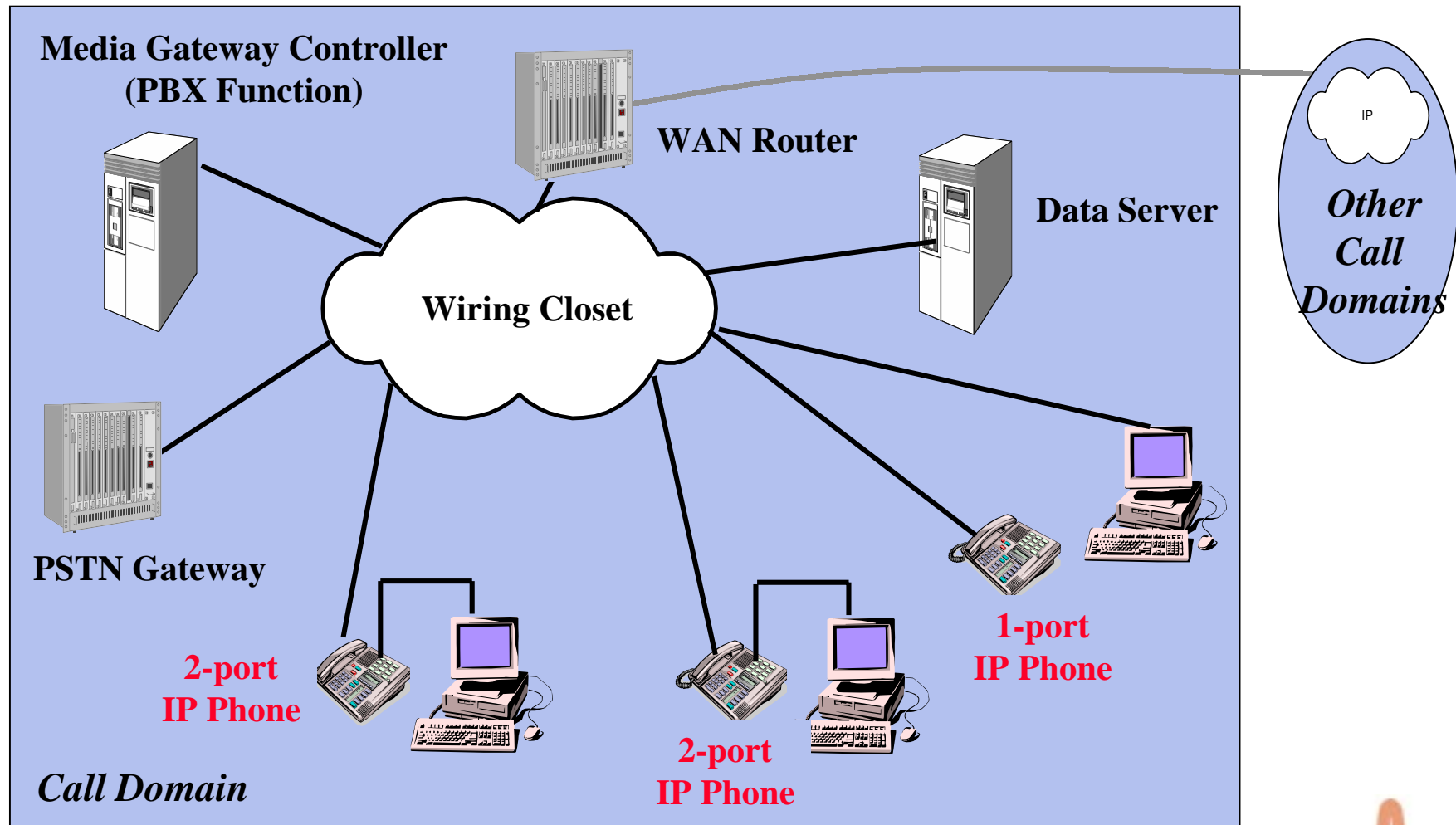

BCM1101

Ethernet Enterprise IP Phone / Gateway Platform

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Enterprise IP Telephony Topology



IP Phone Chip Requirements

- **Single Chip Solution**

- Integrate all key blocks for IP Telephony

- **Low cost**

- **Two External 10/100BASE-T Ethernet Ports**

- One port to network, one port to PC

- **3 port 10/100BaseT Ethernet Switch**

- Switch isolates IP Phone CPU core from PC<->network traffic
 - Hub solution floods CPU with PC<->network traffic, resulting in poor voice quality



IP Phone Chip Requirements

- **Excellent Voice Quality**

- Wideband codecs
- QOS
- Low delay
- Adaptive jitter buffer

- **Support wide selection of vocoders:**

- Narrowband: G.711, G.726, G729A/AB/E, G.723.1/A, G.728, BroadVoice™
- Wideband: G.711, G.722, BroadVoice™

- **Power over Ethernet**

- Built in support
- Low power consumption



IP Phone Chip Requirements

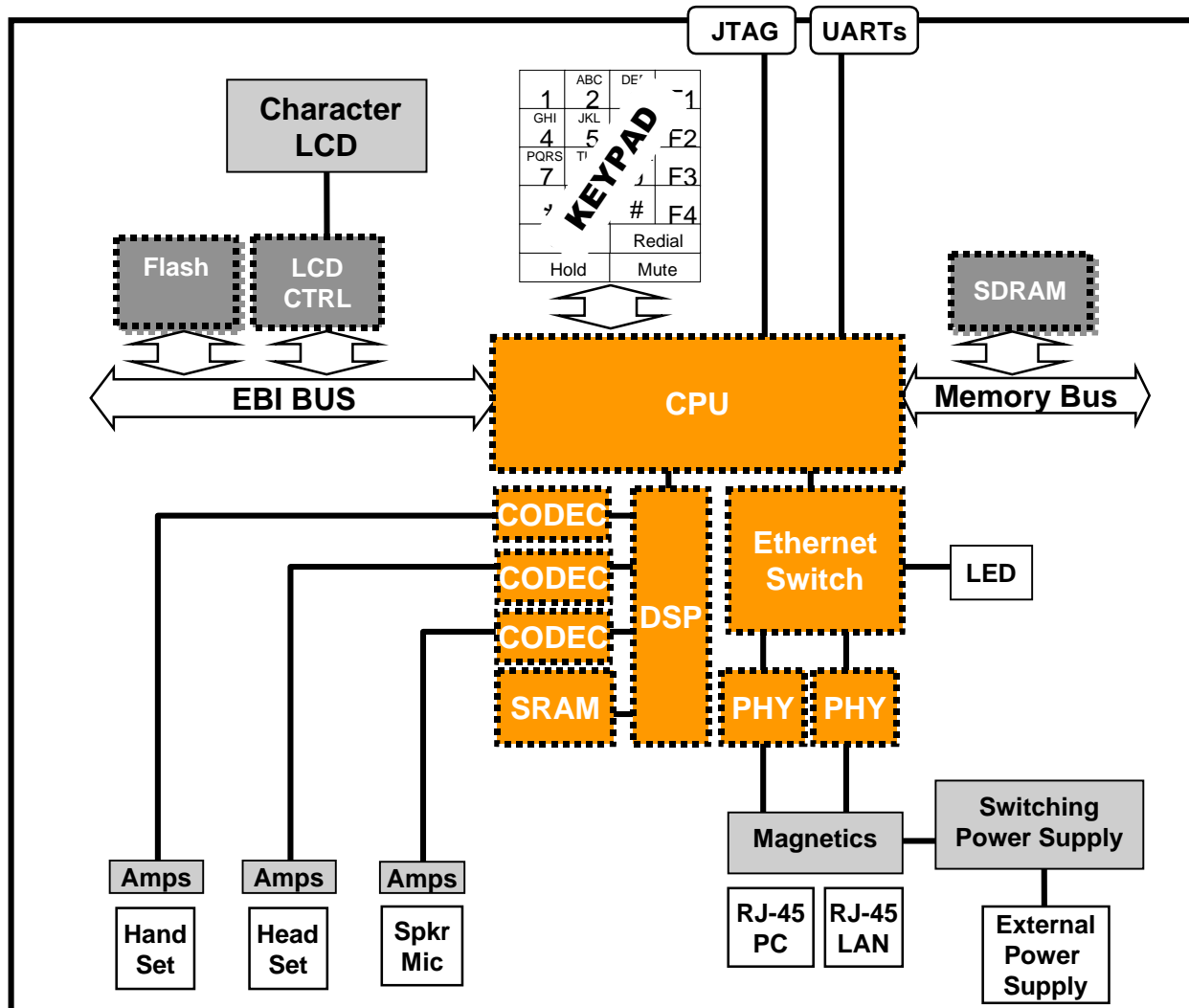
- **Phone Application**

- 3 wideband capable codecs (handset / handsfree / headset)
- Half and full duplex speakerphone
- 3 channel conferencing

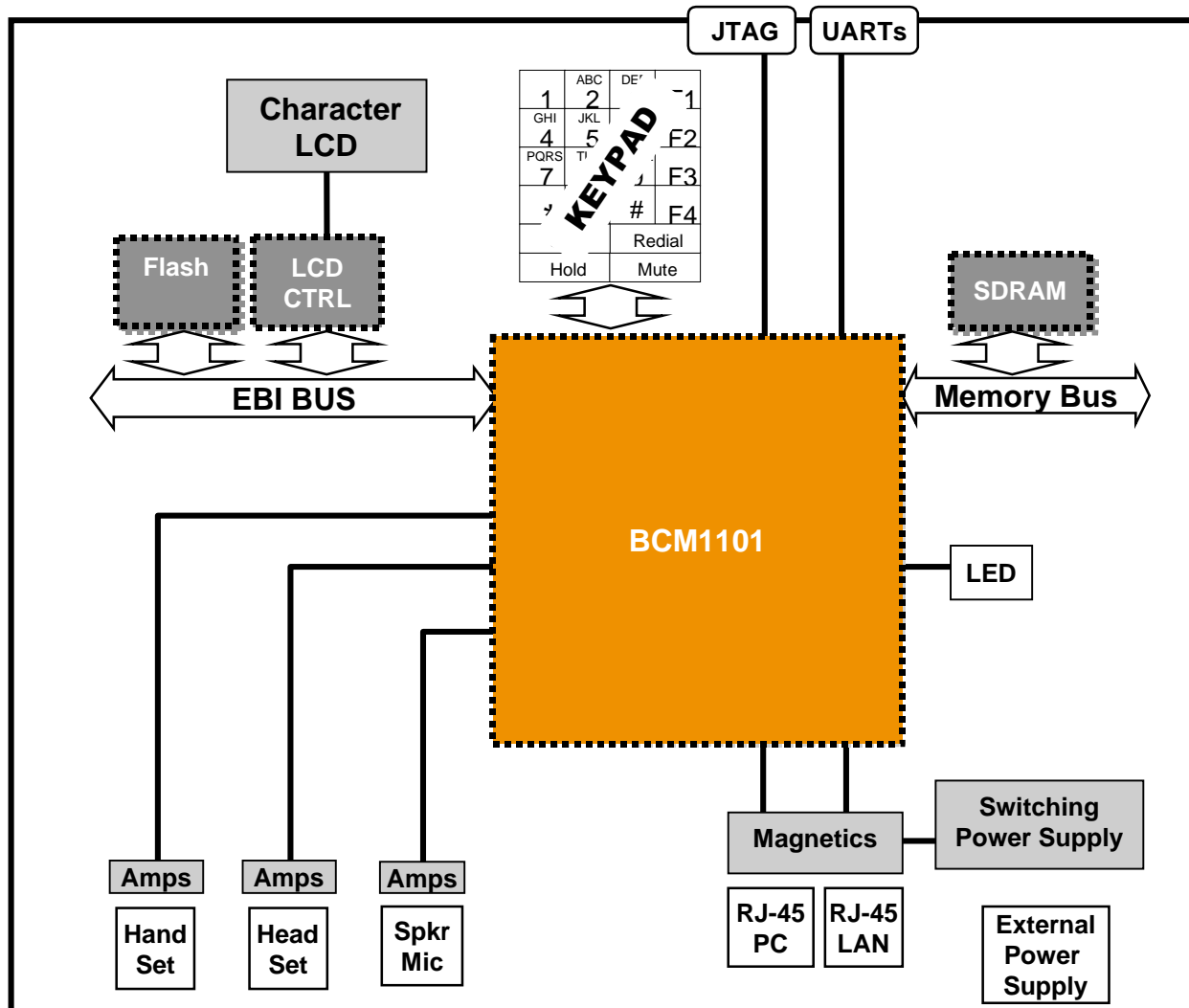
- **Gateway Application**

- Glueless interface to external SLICs
- 2 wideband capable codecs (line 1 / line 2)
- Line echo canceller
- Fax relay / Voice band data
- 3 channel conferencing

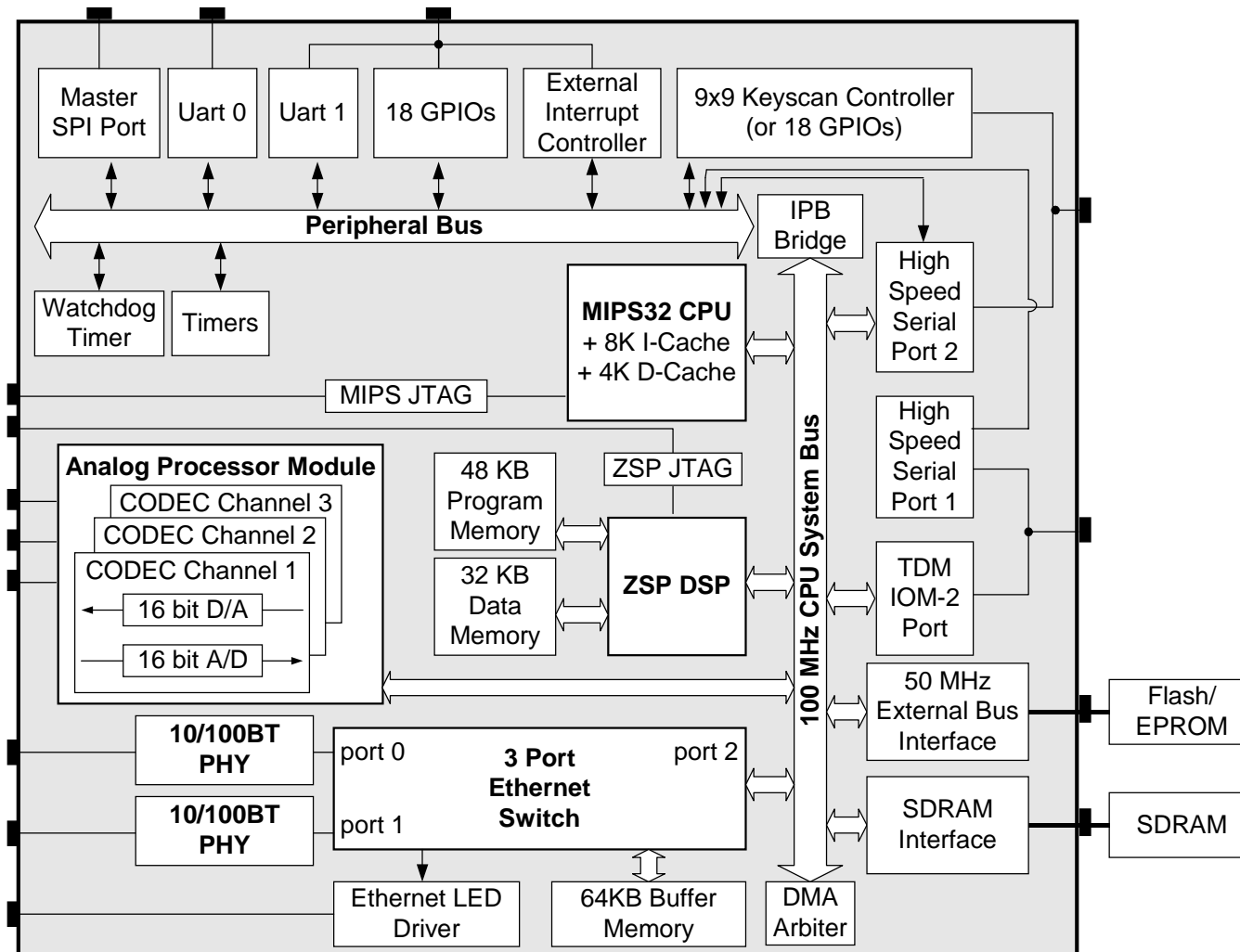
First Generation IP Phone



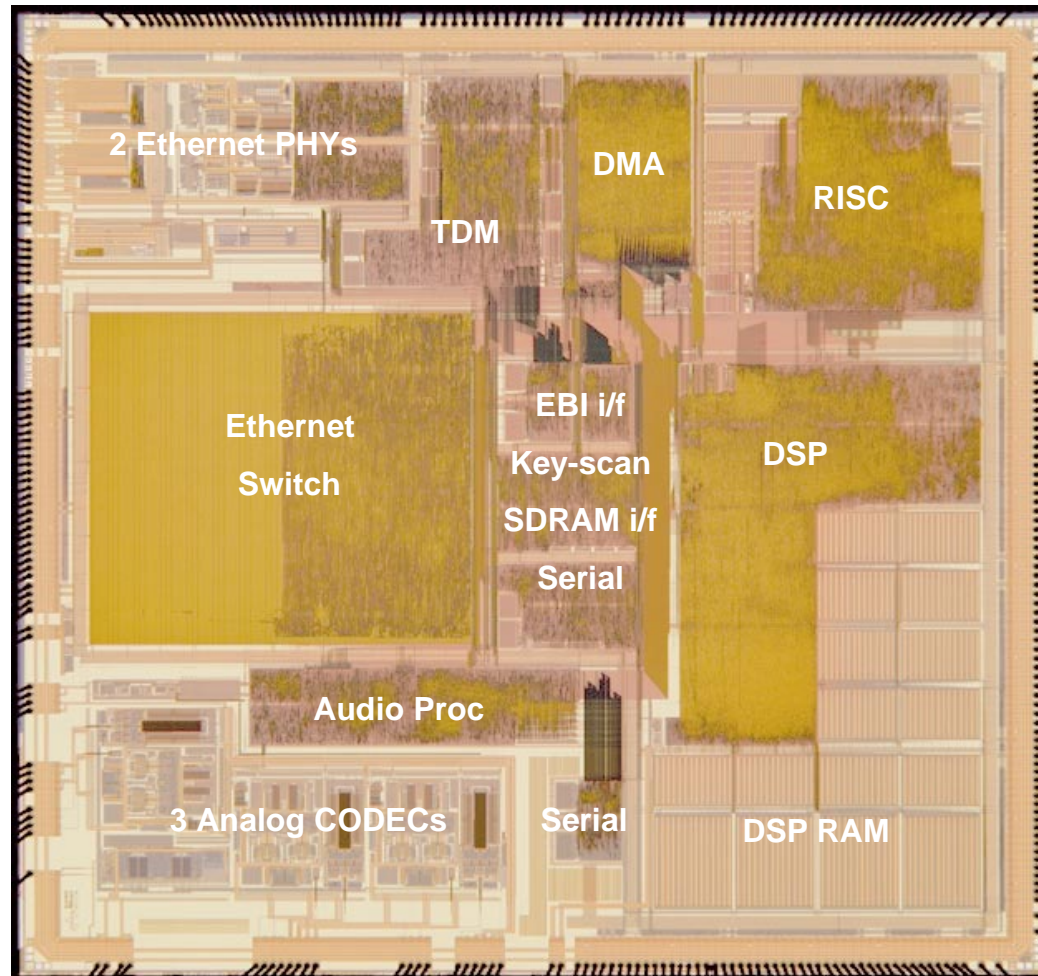
BCM1101 IP Phone



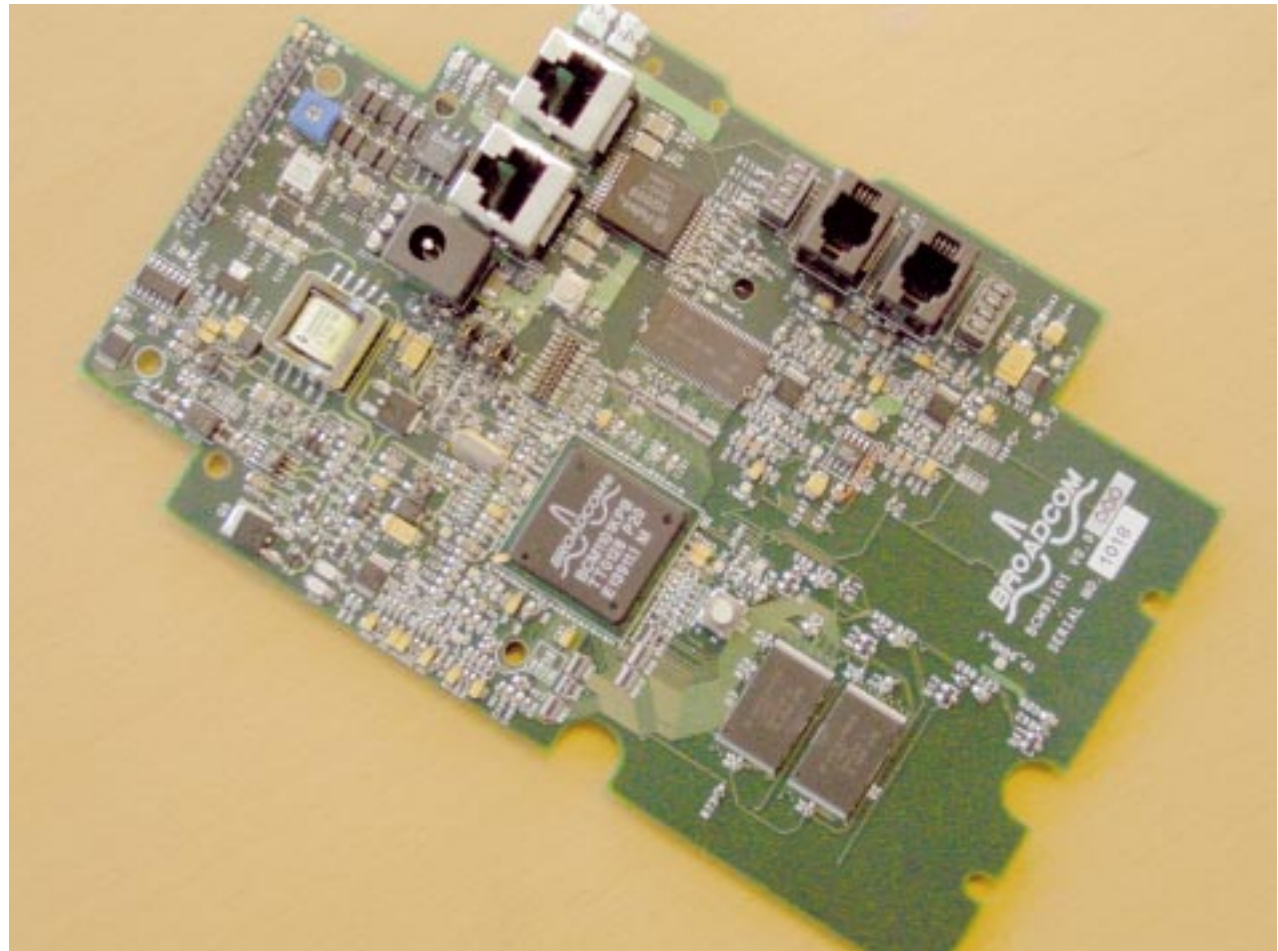
BCM1101



BCM1101



BCM91101 IP Phone Platform



BROADCOM

BCM1101 Chip Features

- **MIPS32 CPU (150 MHz / 165 DMIPS; 8kB I-cache, 4kB D-cache)**
 - IP, RTP, UDP, VoIP protocol stacks (H.323, H.248/Megaco, MGCP, SIP)
 - Realtime OS
- **ZSP DSP (140 MHz / 280 MIPS; 48kB Prog RAM, 32kB Data RAM)**
 - Vcoders (G.711, G.726, G.723.1/A, G.729A/AB/E, G.728, BroadVoice™, G.722.1)
 - 3 channel conference
 - Half & Full Duplex Speakerphone
 - Telephony algorithms: DTMF, Call Progress Tone Generation, etc.
 - Adaptive Jitter Buffer, Packet Loss Concealment
 - Framework (DSP 'RTOS')



BCM1101 Chip Features

- **Three CODECS for simultaneous handset/headset/speakerphone**
 - 16-bit, 8 kHz and 16 kHz (wideband) sampling
- **Non-Blocking Managed Switch**
 - 64 kB buffer enables Wire-Speed Non-Blocking - no dropped packets
 - 802.1p Prioritization ensures voice quality
 - 802.1Q VLAN tagging support for communications security
 - Switch solution is more robust than a repeater hub
- **Two 10/100BASE-T Ethernet transceivers**
 - Power Over Ethernet support (MLP method)
 - Auto MDIX support simplifies network installation
 - LED port for Ethernet status



BCM1101 Chip Features

- **Peripherals**

- 9x9 key-scan supports standard and feature-phone keys
- 2 UARTs and 2 High Speed Serial ports
- 18 GPIO pins
- TDM bus with IOM-2[®] support

- **Physical Features**

- 0.18u process, 1.8/3.3V operation
- 1.1W Peak, 0.3-0.8W Standby Modes
- 256 pin PBGA package
 - Pin assignments designed to enable low cost, 4-layer PCB design

IOM-2 is a registered trademark of Infineon Technologies AG



DSP Memory Requirements

- **Rich DSP functionality requires >200kB RAM**
 - Jitter buffer
 - G.711, G.726, G.723.1/A, G.729A/AB/E, G.728, BroadVoice™, G.722.1
 - Tone generation / detection
 - echo cancellation (for handset / headset / line echo cancellation)
 - Full duplex speakerphone
 - Wideband audio
- **Additional DSP memory needed for future expansion**
 - ie. new codecs, speech recognition, MP3 player
- **Internal SRAM is expensive**



BCM1101 DSP Memory Reduction

- **Distributed DSP Operating System**

- Portion of DSP Operating System runs on MIPS
- Software developer can move non time critical tasks to MIPS (ie. superpacketization, fax relay)

- **Program Paging**

- DMA program and data tables from external SDRAM to DSP memory
- Software development tools make paging transparent to programmer.
- Programmer simply list functions to be paged
- Function is stubbed out with code that sets up the DMA descriptor, pages function, transfer control to page

- **Instance Memory Paging**

- DMA instance memory on demand from external SDRAM
- Once processing is complete, instance memory DMA'ed back to SDRAM

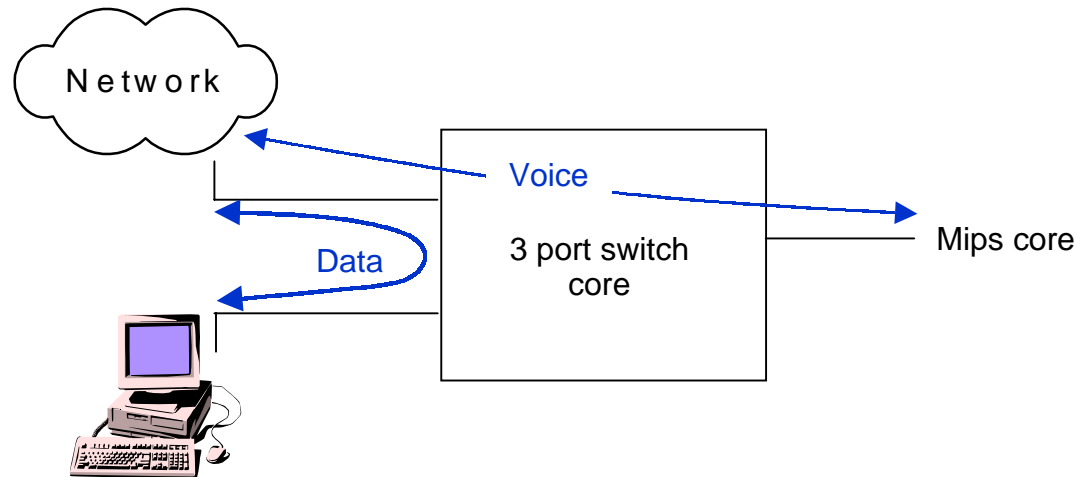


BCM1101 DSP Memory Reduction

- **BCM1101 has 80kB Internal DSP RAM**
 - Traditional architecture requires >200kB
 - 48K Program Memory
 - 32K Data Memory
- **Novel software and hardware architecture**
 - Internal DMA controller is managed by software to page memory on demand
 - Minimizes memory footprint while supporting extensive DSP feature set
 - DSP feature set can be expanded without adding memory
 - No external expensive SRAM required for DSP core
 - Memory pages stored in SDRAM which is shared with MIPS core => no additional external memory needed for DSP



Ethernet Switch Voice Enhancements

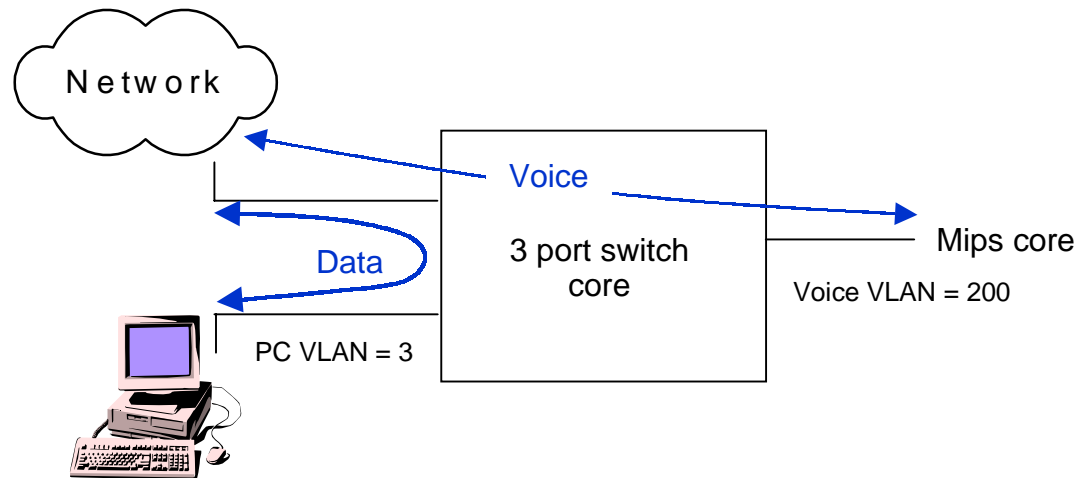


- **802.1p Priority**

- Voice traffic receives priority treatment over data => reduce latency
- 3 bit 802.1p QOS field in Ethernet header
- Switch examines 802.1p field and queues packet into either high or low priority queue
- 2 priority queues per port
- Override mode retags 802.1p field from PC or Network port



Ethernet Switch Voice Enhancements



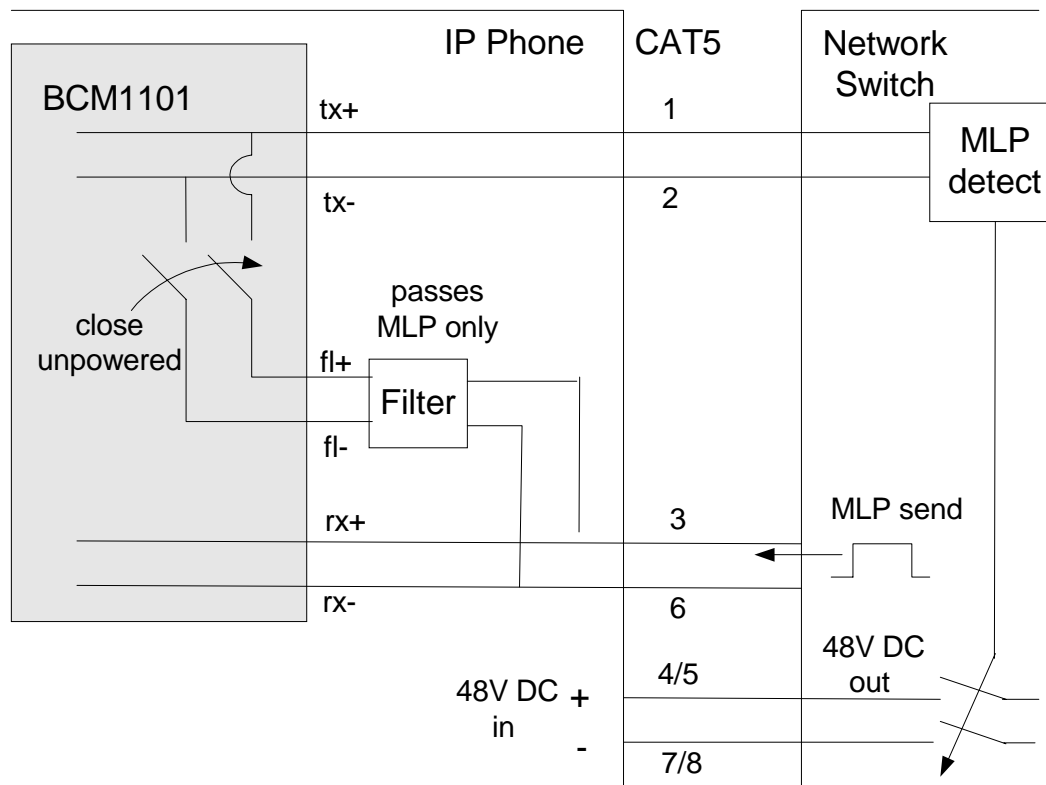
- **802.1Q VLAN**

- Allows network segmentation to increase security and decrease broadcast/multicast traffic
- 12 bit 802.1Q VLAN ID in Ethernet header
- Programmable VLAN ID on each of 3 ports
- Packets only forwarded to port with matching VLAN ID
- Optional VLAN ID removal on outgoing frames
- Optional VLAN ID insertion/retagging on incoming frames



Power Over Ethernet (POE)

- **BCM1101 supports MLP (Modified Link Pulse) method**



Power Over Ethernet

- **Network switch supports POE**

- Phone is unpowered => BCM1101 relay closed
- Network switch does not detect link, transmits link pulses (NLP, FLP, MLP)
- MLP passes through filter
- Network switch detected returned MLP, stops MLP tx
- Network switch supplies power
- BCM1101 relay opened

- **Network switch does not support POE**

- Phone is unpowered => BCM1101 relay closed
- Network switch transmits NLP (Normal Link Pulse) or FLP (Fast Link Pulse)
- Filter blocks NLP and FLP => not looped back to switch
- Network switch operates as normal



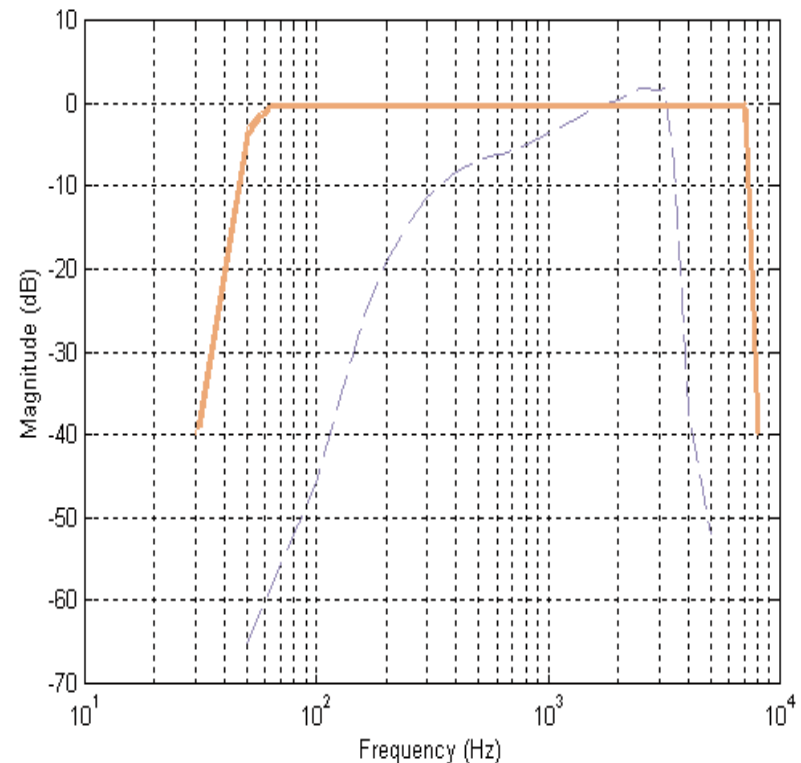
BroadVoice™ Vocoder

- **Wideband Telephony**

- Conventional speech
 - 8 kHz (300 to 3400 Hz - **dash** curve)
- Wideband speech
 - 16 kHz (50 to 7000 Hz **solid** curve)
 - Flat response and added bass and treble
 - More natural-sounding and intelligible
 - But higher bit rate required
 - Distinguishing feature for VoIP

- **BroadVoice™ was developed with the following goals**

- Wideband and Narrowband modes
- Low Complexity / Low Delay / Very High Quality
- Free of third party IPR



BroadVoice™ Features

- **Very high quality**
 - Narrowband BroadVoice16 better than G.723.1, G.728, G.729, and G.729A
 - Wideband BroadVoice32 better than G.722 at 64 kb/s
- **Very low coding delay**
 - only 5 ms, versus 15 ms for G.729 and 37.5 ms for G.723.1
- **Low codec complexity**
 - 13 MIPS for narrowband BroadVoice16 codec
 - 19 MIPS for wideband BroadVoice32 codec
 - Low memory foot print
- **Free of third-party's intellectual property rights (Broadcom owns all IPR)**



Summary

- **Highly integrated single chip IP phone solution**
 - MIPS32 CPU, ZSP DSP, DSP memory, ethernet switch / phy, 3 codecs
- **Hardware/software designed to reduce DSP memory**
 - DMA architecture for program and instance memory paging
 - Distribute DSP operating system allows tasks to run on MIPS
 - Paging allows rich DSP feature set on small memory footprint
 - No external SRAM required for DSP
- **Features for IP Telephony**
 - Wideband codecs
 - 802.1p / 802.1Q Priority support
 - Integrated power over Ethernet support
 - BroadVoice support

